

Names of Men.

Chakla,
Sunka,
Balasache,
Deringa sache,
Poojoon,
Esula,
Puharoo,
Oonti,
Jenti tokla,
Mhedla,
Secuta.

Names of Women.

Phagooni,
Bisaje,
Bisahawa,
Furgunnic.

A. CAMPBELL.

ART. II.—*Researches on the Gale and Hurricane in the Bay of Bengal on the 3rd, 4th, and 5th of June, 1839; with reference to the Theory of the Law of Storms in India.* By HENRY PIDDINGTON.

PART II.

That the hurricane part of the tempest which we are considering was blowing in tolerably well defined circles, has been, I think, clearly shewn in the foregoing part of this memoir. The object of this second part, is to adduce evidence, which shews that it was at the same time both a *gale*, i. e. a strong wind blowing in with tolerable steadiness from one quarter of the compass; and a *hurricane*, namely, a violent wind blowing in a circle or vortex of greater or less diameter. At present too it seems probable, from the dates, that the gale produced the hurricane. We may consider that this storm was one of those which usually occur at the change of the moonsoon from NE. to SW., which in various parts of the Bay may be said to take place between the 15th May and 15th June. It is from the 1st to the 15th June that we look for the rains in Calcutta, though sometimes, as in this year, they may be said to have begun in April. It will be borne in mind then, that whatever follows, whether facts or hypotheses, relates only to the beginning of the SW. monsoon. Future observations will inform us, whether the October Gales as they are called,—though they sometimes occur in November,—are subject to the same or different laws. (The European reader will recollect, that October is the epoch at which the NE. monsoon takes the place of the SW. one.)

If we look at the Bay of Bengal, Map No. II, we shall be struck with the fact, that while it is bounded on the East by the mountain range which stretches from the Malay peninsula to Bootan, often approaching very near the shores, and rising to the height of from 3000 to perhaps 5000 feet on the Arracan coast; it is also bounded, on the West, by the Coromandel range, which supports the Eastern side of the elevated table lands of the Deccan. At the valley of the Mahanuddee (the river of Cuttack) however, at its junction with the Vindiya range, it turns suddenly to the North-Westward and Westward, leaving thus between it and the mountains of Arracan, the wide opening from Point Palmiras to Chittagong, which, to use an orientalism, is the *gate* to the plains of Bengal.

The salient angle, formed by the corner where the Vindiya and Coromandel ranges meet, and the entering one, where the Bootan, or Himalaya, and Arracan and Cachar ranges join (leaving however the valley of Assam as an opening for the great Burrumpooter to flow through,) thus form, as it were, an angular channel; through which all the lower strata of the current of the SW. monsoon may be supposed to find their way over the plains of Bengal and up the valley of the Ganges; and this is their natural course. But we may suppose that the SW. monsoon when urged to any great force at the mouth of the Bay, about Ceylon, must strike against the mountain ranges of Arracan in about from lat. 16° , which is that of Cape Negrais, to lat. 20° or 21° ; or about that of Arracan; and, being deflected thence, must turn off in a paraboloidal line towards the great opening offered by the low lands at the head of the Bay, and thence proceed up the valley of the Ganges as before.

But when the head of the Gale is thus deflected, it may meet also with that portion of the monsoon which has blown along the Coromandel range and coast—called the “long-shore wind,” by the old navigators—which has a much shorter distance to travel; and there occasion an eddy of variable winds, whirlwind or hurricane, according to the force of the first impulse—and this again influenced too, doubtless, by many causes to which we are yet strangers.

If this theory be true for these tempests, we should look to find points, about the meeting of the two currents, varying in position according to their respective forces, at which, during these gales, it should be comparatively calm, or blowing but moderately; and it is curious that at Balasore, in latitude $21^{\circ} 28'$, and at the Black Pagoda in $19^{\circ} 62'$ N. this comparative calm is found to have existed. My authority for this is the following letter.

Balasore, July 31st, 1839.

DEAR SIR,—I should have been much at your service in giving you all the requisite information concerning the gale here, had any taken place, but we had only strong gusts of wind at NE. to SE. with uncommon heavy rain on the 5th, 6th, and part of the 7th of June, which even to this day has kept back the rice crops. The thermometer fell to $81\frac{1}{2}^{\circ}$, and unluckily my barometer was broken a few days prior, so that we could only foretel a gale coming on by the blackness of the heavens to the Eastward; which gale did not reach from the Northward of Point Palmiras to Balasore, but blew hard from Point Palmiras to below Pooree to the Southward. No vessels were lost in the Balasore roads; but to the Eastward they may have been lost, as a Telingah topgallant mast was picked up, besides pieces of deal boxes, supposed to have contained glass-ware, marked "*Protector*," which vessel was lost to the Eastward, between the reefs, last October.

Gales at Kedgeree, though blowing dead to windward of us, distant seventy-five miles, do not always reach this coast; as in the May Hurricane of 1833, when the "*Duke of York*" was blown from her moorings at Saugor across to Hidgelee, and became a wreck, yet the gale did not reach here, although the bank to the Eastward in the heavens so plainly indicated a gale, that every person here barred up their doors and nailed them. We only had a good topgallant breeze.

The Neilgherry Hills appear to influence the winds much on the coast north of Point Palmiras, as the winds are generally throughout the SW. monsoon, SW. to W. in the morning to 7 A. M., veering round to S. and SE. P. M.; and in the NE. monsoon, W. to NW. veering round to NE. after 8 A. M.

(Signed) A. BOND.

Mr. Richardson, Branch Pilot, informs me, moreover, that during the fury of the Gale of 1833, in which the "*Duke of York*" was wrecked, and he himself was driving about with all his anchors down, some passengers whom he had previously landed at the Black Pagoda were upon the top of it, and felt no excessively violent wind, though they saw the horizon very black, and the sea dreadfully agitated to the North Westward of them.

The slow rate at which our vortices travel onwards is very remarkable, but seems, if future observation should confirm it, to afford countenance to this theory; for, as before said, we may consider them as pent up between the current passing round the vortex of the parabola and the Coromandel range; and no doubt to feel, as water in similar channels would do, the repulsion from these last. It is clear, as shewn in p. 576, by the log of the "*Indian Oak*," that the monsoon was blowing up along the coast as far as Vizagapatam, from between which and Gan-

jam, to Point Palmiras, the Hurricane was probably felt. Its limit to the North we well know to have been between Point Palmiras and Balasore, but I could obtain no intelligence from Ganjam to fix a limit to the South.

We should also find that, as the current of air proceeds up the valley of the Ganges to the North Westward, it should give rise to an Easterly Gale, which has also in this instance occurred, as will be seen by the following extracts, the first being from a very able and interesting letter from Mr. Ravenshaw, of the Civil Service, dated Chuprah in Behar, lat. $25^{\circ} 46'$ N. long. $84^{\circ} 46'$ E.

Chuprah, July 17th, 1839.

DEAR SIR,—Having observed in the Newspapers that you are desirous of obtaining information connected with the Gale which occurred in the Bay of Bengal from the 3rd to the 5th June inclusive, I have the pleasure to contribute my mite to the stock of facts which you are engaged in collecting. The enclosed extract from my Register will shew the height of the Bar. and Ther. at $10\frac{1}{2}$ A. M. during the Gale, and for some days succeeding it. I regret that my official duties prevented me from taking observations at $4\frac{1}{2}$ P. M.; but I hope the small amount of information afforded will not be without use, in shewing the direction and duration of the Gale of this district, inland from the Bay of Bengal. It will be remarked, that the Gale did not commence here until the 4th instead of the 3rd June, and that it terminated on the 7th instead of the 5th. The Bar. kept falling during the continuance of the Gale, and strange to say did not reach its minimum until the day after the violence of the Gale had ceased, i. e. the 8th. The direction of the Gale was nearly due East, but on the 8th the wind shifted to the SW. and West, and on the 9th blew as furiously from the latter quarter as it had previously done from the East; towards evening, however, it shifted to the NE. On the 10th it changed to SE., on the 11th to SW.; and the following day to the West. On the 14th and 15th it again veered to the NE. and EbN. until on the 16th it resumed its old position of East, which is the usual direction from which it blows at this season of the year. From the above it would appear that the wind, after the violence of the Gale had subsided, acquired a rotatory motion and turned twice round the compass in a Southerly direction before it recovered its equilibrium. By letters received at the time from Mootebarry, 60 miles North of Chuprah, and from Gyah, about 90 miles South of this station, I learnt that the Gale occurred with equal violence at those places. The breadth of the column of air put in motion was therefore at least 150 miles, and probably much greater. It would be interesting to ascertain the exact limits of this Gale inland as well as at sea, which object might be effected by your addressing a circular letter to the residents at each of the principal stations in the Western Provinces e. g. Allahabad, Cawnpore, Agra, Delhi and Saharunpore. In-

formation from these points would probably give the extreme length to which the Gale extended, as information obtained from Jubbulpore, Gwalior, and Ajmere, would shew the extreme breadth. I do not recollect at present from what direction you stated the Gale to have blown in the Bay of Bengal, but if from the SW., the usual course of the monsoon, it is difficult to account for its blowing here from the East, unless we suppose the column of air to have been driven against the Assam and Himalaya Mountains, and by them turned in a Westerly course. In this event, it is probable that the Gale may have subsequently followed the direction of the mountains NW. perhaps as far as Hurdwar.

I conclude that it is not your intention to confine your observations and inquiries to the Gale under consideration, but to all storms of magnitude in the Bay, or its vicinity. The Gale which seems to occur almost annually in the Bay of Bengal in the month of October, would, from its regular recurrence, form an excellent subject for observation. It was felt at Chuprah during the two years that I have been stationed here. On the first occasion it blew (to the best of my recollection) from the East, whereas last year it came from the West.

It appears to me very desirable that either Government or some public body like the Asiatic Society, should take measures for securing an uninterrupted official record, not only of the periodical and occasional storms which extend generally over large tracts of country, but also of local atmospherical peculiarities—the changes in the direction of winds and storms occasioned by mountains and the larger rivers—also of the general character of the seasons in different parts of the country—the paucity or abundance of rain—the minimum rise of the Ganges, Burrumpooter, &c.—the price of grain as affected by the seasons—the date of the commencement and termination of the rains—of the hot winds—or of any other prevailing winds.

The Asiatic Society through its numerous members might, I should imagine, without difficulty obtain information on the points adverted to from all the principal stations in India, which should be annually digested and published in their *Journal*. These again will be compared and generalized every 10 years or so by a Meteorological Committee of the Society. The Asiatic Societies of Madras and Bombay might be requested to adopt the same system throughout their respective Presidencies, so that the observations might embrace the whole of India. Such a combination of laborers in the cause, and the consequent accumulation of facts, assisted by the rapid progress of science in these days, would almost justify the hope that we may ultimately arrive at the discovery of some general laws by which the seasons are regulated; and by which we may be able to foresee and to guard against both inundation and famine, in a country where their ravages are often so destructive to life and property.

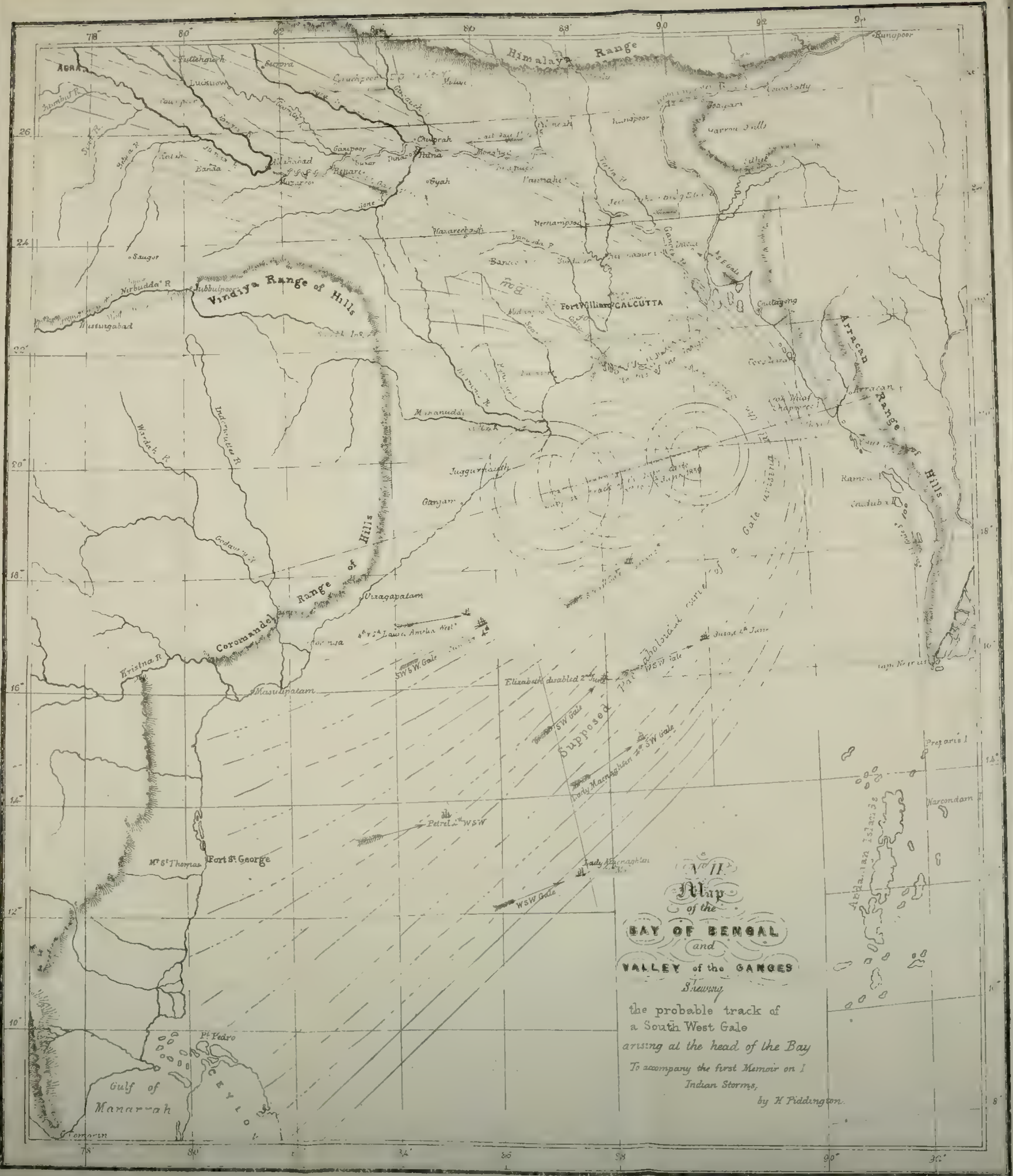
(Signed)

E. RAVENSHAW.

1839.	Bar. at 10½ A. M.	Ther. attached	Bar. at 4½ P. M.	Ther. attached	Bar. at 10 P. M.	Ther. —	Remarks.
June 4th	No observation.		} Strong and continued gale from East, with occasional rain. } Rain; wind SW. shifting to West. } Ditto, W. do. to NE. } Ditto, Wind SE. } Ditto, SW. } Ditto, W. } Ditto, W. } Ditto, NE. } Ditto, EbN. } East, the usual direction of the wind at this season.
5	29-50	86	....	....	....	....
6	29-42	86½	....	....	....	....
7	29-32	83	....	....	....	....
8	29-30	84	....	....	....	....
9	29-34	81½	29-32	82½	....	....
10	29-40	82	....	....	....	....
11	29-39	83	....	....	....	....
12	29-38	85	....	....	....	....
13	29-38	85	....	....	....	....
14	29-47	87	....	....	....	....
15	29-58	87	....	....	....	....

N. B. This gale extended in *breadth* from Mootebarry, 60 miles North of Chuprah, to Gyah, 90 miles South—and perhaps further, but of this I have no authentic intelligence.

As far then as our present knowledge extends, and referring to the state of the Gale in the Southern part of the Bay, we find that the impulse, which may be said to begin to be violently felt on the 31st by the *Susan*, did not reach Chuprah till the 4th, when it produced an Easterly Gale, terminating on the 7th, shifting to the South-West and West on the 8th; the counter-gale and eddies, if we may so call them, being only the irregular movements of the various currents produced by this great derangement of the usual equilibrium of the aerial currents, which, as is remarked, are usually from the East at this season; affording also a proof towards the theory which I have ventured to offer. When the monsoon slackens the Southerly and South-Westerly gales, and currents may find their way as far inland as this place. The dates show that the Gale did not begin at the point to which it blew, but that it was a progressive impulse travelling about the direction which I have laid down. Assuming this theory as a *guide* only, let us now see how it accords with the facts we already possess here. By referring to the Map, No. II. we see that though along the coast from Madras to Vizagapatam, by the Indian Oak's log at Masulipatam, by the Master Attendant's report from Coringa, and up to the 3rd at noon by the Laurel Amelia's log, it was fine, though threatening; yet from the 31st May to the 5th June, by the logs of the Lady Macnaghten, Petrel, Susan, Jumna, and Laurel Amelia—to which too we might add those of the Nine, Eden, and Mobile—a severe gale was blowing between WbS. and SW. diagonally across the Bay, in lines about parallel to one drawn from the centre of Ceylon to Cape Negrais, the termination of the Arracan coast. We find that at Cheduba on the



NOTI
 Map
 of the
BAY OF BENGAL
 and
VALLEY of the GANGES
 Showing

the probable track of
 a South West Gale
 arising at the head of the Bay
 To accompany the first Memoir on
 Indian Storms,
 by H Piddington.

2nd, and part of the 3rd, the John William Dare had a severe gale from S. to SSE. the gale being then deflected by the mountains of that coast. At the harbour of Akyab No. 27. we find that our meagre notices give us "Easterly winds with hard gales" on the 2nd; on the 3rd, and 4th, "brisk;" on the 5th, "gales;" and on the 6th, SW. winds.

At Dacca* Dr. Lamb's Register gives as follows:—

	Winds.	Bar. 10 A. M.	Ther. Noon.
June 1st.	SE. East SE.	29.68	90
2nd.	SS. East,	„ 64	90
3rd.	East South SE.	„ 64	91 3 inches of rain.
4th.	East SE. South,	„ 68	88½ 6 inches of rain.
5th.	South SE. SbE.	„ 71	85

So that here the winds were varying between South and East.

At Jellinghee, in lat. 24° 8', long. 88° 42' E. about 140 miles WbN. of Dacca, and about 100 NbE. of Calcutta, at the spot where the river of that name branches off from the great Ganges, a memorandum informs me as follows:—

- June 6th, strong Easterly gales with frequent showers.
- „ 7th, ditto ditto.
- „ 8th and 9th, Frequent showers and cloudy weather.

The following is an extract of a letter and memorandum from H. B. Beresford, Esq. Deputy Collector, Purneah.

"The observations from 4th to 10th inclusive, in the following memorandum, were made on the Ganges, some miles south of Purneah—at least so I understand Mr. Palmer to say:"

Transcript of Extract of Day Book, 1839.

June 1st.	Wind E. blew hard and rained in the morning.
2nd.	Wind E. a warm clear day.
3rd.	Wind E. clear morning, rained heavily in the afternoon, and blew hard from South at night.
4th.	Wind E. blew fresh.
5th.	A strong gale from the East—rained a great deal—a wet rainy night.
6th.	Blew hard the whole day from the East, and squalls accompanied with rain came frequently.
7th.	Wind SE. in the morning—East at noon; died away in the afternoon, rained a little.
8th.	Wind S. and SE.
9th.	Wind East—rained a great deal and blew fresh.
10th.	Wind ESW. and E. again—rained a great deal.

* The Indigo planters of the district of Dacca and the Eastern part of Jessore are well aware of the tendency of strong Easterly winds to cause rapid rises of the river, and severe loss to them by inundating their plant. If we suppose the Easterly gale to be a Southerly and South Westerly one in the Bay, we obtain an additional reason for this, to the common one of the Easterly gale being partly against the current of the Ganges; i. e. the waters of the ocean are driven up into the NE. corner of the Bay.

“The inclosed notes I made in original, and regret not having it in my power to comply more fully with your request.”

June, 1839.

- June 1st. Light airs from NE. to E. cloudy at times.
 2nd. Ditto, Ditto.
 3rd. ENE. cloudy, or slight showers from ESE.
 4th. Ditto, ditto light fresh breezes with slight showers.
 5th. Heavy ENE. wind, very cloudy with light showers.
 6th. Ditto ENE. with constant sleet and rain.
 7th. Heavy ENE. with sleet, wind veered S. to SSE. occasional showers.
 8th. Heavy ENE. veering round to South with rain—night, Northerly.
 9th. Fresh ENE. cloudy with heavy showers.
 10th. Rain almost all day—clouds flying from East—Light airs from West, a great deal of rain has fallen, the nullahs rising very high, threatening to overtop their banks.*

At Ghazeeport lat. $25^{\circ} 35'$ N. long. $83^{\circ} 33'$ E. and 41 miles East of Benares and 84 miles W. $\frac{1}{2}$ S. from Chuprah, Dr. Jackson kindly forwards me a journal for the month of June, from which the following is an extract, which I copy to the 11th, to shew how remarkably they agree with those of Mr. Ravenshaw from Chuprah, in the sudden change of the wind, from ESE.—which we may call its average from the 1st to the 7th,—to SW. on the 8th. The subsequent changes seem to indicate, as before said, that the more direct current of the monsoon had for a short time forced its way upwards; for the remainder of the month the wind is variable from E. to W. with sultry weather, as usual there in the month of June.

Date.	Winds.	Ther.	June, 1839.—Remarks, &c.
1	ESE.	98	Pleasant breezes, fair weather, 11 A. M. cloudy with a few drops of rain, hot and sultry.
2	ESE.	98	Light breezes, fair weather, hot and sultry.
3	ESE.	99	Fresh ditto, cloudy, at intervals hot and sultry; at 1/30 P. M. a squall, no rain.
4	ESE.	96	Fresh breezes, cloudy at intervals, with hard squalls, fair weather.
5	ESbE.	92	A. M. cloudy and showery, hard gales with showers at intervals.
6	SEbE.	86	Hard gales, dark cldy. weather, showers at intervals, night rainy.
7	SEbE.	86	Ditto ditto ditto ditto with heavy rain, 7 P. M. wind shifted to the SW.
8	SW.	80	Dark cloudy rainy weather, with hard squalls of wind, 6 P. M. fair and continued during night.
9	SW.toESE.	80	Morning dark, cloudy and fair, which continued throughout, 5 P. M. wind shifted to the ESE.
10	ESE.	84	At 3 A. M. dark and cloudy with drizzling rain, at 5 fair, moderate breezes.
11	WSW.	88	A. M. dark and cloudy, with thunder, lightning and rain, at 8 fair moderate breezes, passing clouds.

GHAZEEPORE,
September 14th, 1839.

J. JACKSON,
Civil Surgeon.

* In the Northern parts of the district much more rain fell, both the Coosey and Mahanuddee were uncommonly high for the time of the year.

From Gorruckpoor, in lat. 26° 45' N. long. 83° 22' E. I learn by one letter that it blew a gale from the East on the night of the 5th and 6th June; strongly from the East during the 6th, and until the afternoon of the 7th, when it was NE., also blowing strongly; on the morning of the 8th it was NW. strong, and towards the afternoon it shifted to the East and moderated. The rain commenced at noon on the 6th and continued night and day till the afternoon of the 8th, when it ceased.

From Gorruckpoor I have also by the kindness of Mr. Vicars the following memorandum.

Gorruckpoor, 23rd September, 1839.

At the request of Mr. Bridgman, I send you an extract from my Meteorological Journal, it is a very unfortunate circumstance that I should have neglected to register the barometer and thermometer until the 7th of June, I however, noted the direction of the winds and the maximum of the Thermometer, which is better than nothing, and perhaps may answer your purpose; there was a storm from the East with rain on the 31st May.

Yours sincerely,
N. VICARS.

June. Date.	10 A. M.			4 P. M.			Remarks.	
	Bar.	Alt. Ther.	Detch. Ther.	Bar.	Alt. Ther.	Detch. Ther.	A. M.	P. M.
1	Max.	of	ther.	91·0	min.	89·2	Estly. moderate, none.	Easterly.
2	Do.	....	Do.	91·2	....	....	Easterly (minimum of Bar. 28·873)	None.
3	Do.	....	Do.	92·0	....	....	Easterly, moderate.	Storm rain, no wind.
4	Do.	Do.	....	91·5	....	....	Easterly, strong.	Easterly, strong.
5	Do.	Do.	....	88·0	....	....	Easterly, showers.	Easterly, strong.
6	Do.	....	Do.	86·0	....	....	Easterly, stg. hvy. rain (min. of Bar. 28·808)	Easterly, strong.
7	28·970	....	81·0	28·750	....	80·0	Estly. stg. rain all day.	Easterly, strong.
8	28·788	77·5	78·5	28·777	79·5	77·8	Easterly, strong, heavy rain till 4 P. M.	Easterly, strong.
9	28·902	80·7	80·2	28·940	... 84·0	...	Easterly, strong, cloudy.	Easterly.
10	28·964	81·0	81·0	28·800	82·8	83·0	Easterly, cloudy.	Variable.

From Mirzapore lat. 25° 10' N. long. 85° 35' E. I am indebted to Mr. Stuart for the following memorandum of the weather, from 1st to 10th June, 1839.

1st June, Thermometer,	..	88·	..	Fresh Easterly Breeze.
2nd ditto,	..	86·	..	Morning wind Easterly. Noon dreadfully hot and blowing strong from the NW.
3rd ditto,	..	90·	..	Not a breath of wind, until 6 A. M.
4th ditto,	..	88·	..	Sultry night—strong Easterly wind.

5th ditto,	„	..	87	..	Blowing heavy from the East, showers, noon blowing very fresh and weather wild looking.
6th ditto,	„	..	80	..	A regular gale from the East with drizzling rain, noon gale increasing and more rain, evening stormy and wet.
7th ditto,	„	..	80	..	Severe squalls through the night from the East with heavy and incessant rain, noon blowing heavier, rained more Northerly, evening raining very hard.
8th ditto,	„	..	80	..	Very wet morning, cleared up about nine.
9th ditto,	„	..	80	..	Gloomy morning with distant thunder.
10th ditto,	„	..	80	..	Heavy Squalls through the night, torrents of rain, cleared up at 8 A. M. noon close, calm and sultry.

My attention was drawn to this theory while endeavouring to trace some barometric curve, and some relation between it and the magnetic equator,* and withal some law which might theoretically account for the paraboloidal course of the West Indian and American hurricanes, as shown by Mr. Redfield and Col. Reid; and the singular difference shown by the track of our Hurricane led me to suppose that it might perhaps move in the axis of the parabola? Mr. Ravenshaw's letter shortly afterwards gave much credit to these views, and subsequent facts serve to justify our asserting that for this time at least it has done so.

If we describe, as I have done on the Map No. II, a great parabola, one branch of which stretches towards Ceylon, and the other up to the valley of the Ganges towards Agra, the vortex being towards Arracan, and the axis in the line of the supposed track of the Hurricane; it will be found that the focus of such a parabola falls in about lat. $19^{\circ} 36'$ N. long. $88^{\circ} 10'$ E. which was about the centre of the Hurricane on the 4th. These sort of lines are of course arbitrary, but still the coincidence is novel and curious; whether we look upon the whirls of the Hurricane to have been produced by the mere dynamic action of the streams of air, like the eddies within the bends of a river flowing through a curved channel, or suppose that these vortices are Thermo-electric Phænomena, produced by the sudden transfer of great volumes of the caloric and moisture of the stream of air from the warm equatorial regions to the colder ones toward and beyond the tropics. The remarks on the warmth of the weather in the logs, and the thermometrical

* It may be worth remarking that while this hurricane seems to have travelled from East to West or nearly parallel to the direction of the Magnetic Equator as laid down by Biot, those of the West Indies seem for the most part to come from the South Eastward, which is also there the direction of the plane of the Magnetic Equator. The "Raleigh's" Hurricane in the China Seas seems too to have travelled in this direction.

register, with the peculiar state of the atmosphere so well described in the remarks of Captain Paterson, of the H. C. S. *Amherst*—and her track from Akyab we must remember was almost in the direction of the path of the hurricane till it overtook her at the Sand Heads—are well worth considering.

These are but vague theories, it will be said, but it will not be forgotten that theories on a new subject, like torches in exploring dark caverns often lead us to the passage we seek; though not by the road we expected. “We have only to be ready to lay them aside when they have served our turn,”* and if I venture to introduce this one here it is to point attention to the importance of obtaining electric observations if possible.

The slow rate at which the vortex appears to have travelled also seems to show, as before remarked, that it was, as it were, pent up between the great stream of air blowing along the Arracan range and the Coromandel Hills. We see analogous instances to this in the small bays at the sides of rivers, where while there is one part of the stream turning round the shores of it and another flowing from point to point, we see the eddies are from time to time found almost stationary about the middle of the bay.†

I wish to be understood here however as suggesting probable comparisons rather than advancing a theory.

Col. Reid and Mr. Redfield give from ten to thirty miles per hour for the rates at which the centres of their different vortices have probably travelled onwards. If our centres are correctly laid down; and I think there is good evidence that at least those of the 4th and 5th are so; it appears that from the 3rd to the 4th the Hurricane travelled onwards only about 100 miles, or say 4-16 per hour, and from the 4th to the 5th about 70 or 83 miles per hour. This again is conformable to what we observe in the bends of a stream where the eddies seem to start from some point, and move onwards with more rapidity in the first part of their course than latterly. Should future experience confirm this instance of the slow progress of our Hurricane, it will become an important element in any calculation to be made by the seaman for avoiding their violence.

* Sir John Herschel.

† In the rivers of India banks are often formed at these points, which ending by choking the stream as the river becomes lower, changes its channel in succeeding years.

Practical Remarks and Deductions.

I have quoted at p. 563 an opinion expressed in my hearing, that it was thought by the individual that "they would not make much of it." Few I think who have perused the preceding pages, will be inclined to repeat this, but still as the plain man and the practical seaman may not so readily arrive at *all* the conclusions to be drawn from the knowledge we have collected of this single tempest, I have been induced to sum them up here.

My original intention was to delay doing this, and even the publication of this memoir, until I could collect also what was to be gleaned from the records now existing of our former gales and hurricanes, and then accompany the whole with practical deductions; but it was suggested to me by Professor O'Shaughnessy, that by the delay which this would occasion, we should lose the opportunity of exciting public attention to the subject before the approach of the autumnal gales, and moreover, that even by publishing our knowledge in this yet imperfect state, we might nevertheless, possibly, avert mischief. This I thought sound counsel, and therefore propose to make our former Indian tempests the subject of a future memoir.

It will then be recollected that what is here said is merely the amount of our *present* knowledge, and that what is said is rather meant as a suggestion than as a rule. I shall however distinctly state the grounds from which the various inferences are drawn, and it will be for every man to exercise his own judgment thereupon; I shall also acknowledge when I borrow from Colonel Reid, or other writers.

Clearly to comprehend this theory of gales and hurricanes, let us begin with the *words*. As I have elsewhere said, the words are not to be used so much with relation to the force of the wind in a storm, as to its motion.

A *storm*, or tempest, may mean either a Gale or Hurricane, but it always means a storm of *wind*, and not, as frequently used by landmen, one of thunder and lightning only; unless so expressed.

A *gale* means a storm of wind, the direction of which is tolerably steady for a long time, sometimes not only for days but for weeks.

A hurricane means a *turning* storm of wind blowing with great violence, and shifting more or less suddenly, so as to blow half or entirely round the compass in a few hours.

With this explanation of our words we shall better understand the things treated of.

The present state of our knowledge seems to show that for the West Indies, Bay of Bengal, and China Sea, the wind in a hurricane

has two motions, the one a turning or veering round upon a centre, and the other a straight or curved motion forwards, so that it is both turning round and rolling forward at the same time. It appears also that it turns, when it occurs on the North side of the Equator from the East, or the right hand, by the North, towards the West; or *contrary* to the hands of a watch; and in the Southern hemisphere, that its motion is the contrary way, or *with* the hands of a watch. The foregoing memoir with the charts and diagrams shew that this rule holds good at least for our storm of June last; and that the wind was really blowing in great circles in a direction as described; i. e. against that of the hands of a watch. We assume then for the present, that the hurricanes in the Bay of Bengal *always* follow this law. We do not yet positively *know* that such is the case, but it is the most probable opinion.

If we describe on a piece of paper a few concentric circles, like those in the diagrams, and marking a little compass with its *fleur de lis* to the North in the middle make four arrows at the top, bottom, and two sides, writing against them as in the diagram, East-wind, North-wind, West-wind and South-wind, and then cut this out with scissors, we shall have what is called a *Hurricane-circle* or *Hurricane-card*.

The use of this is to lay it down upon any part of a chart. We may also cut out a little spindle-shaped piece to represent our ship, and place this in that quarter of the card at which the wind is found.

The card may be supposed to represent a circle of fifty or of five hundred miles in diameter, as we please; and one which would fill up the head of the Bay of Bengal would show, on our map No. II, the wind South on the Arracan coast, East at the Sand-Heads, North on the coast of Coromandel, and West across the Bay.

We have now to judge of three important points, What is the track of the hurricane if it is to be one? In what direction does it bear from us now? How far are we from its centre?

We do not yet know what is the usual track of our Indian hurricanes. We know from Col. Reid's and Mr. Redfield's researches that those of the West Indies begin about the Leeward Islands, travel to the WNW. and then round the shores of the Gulf of Mexico, and following the Gulf Stream, are lost in the Atlantic between the Bermudas and Halifax; and they have investigated a sufficient number to show that this may be taken as a general rule. Those also of the Mauritius seem to come from the Eastward. All we yet know positively here is the course of this single tempest; and hence the great necessity of further observation and research, to which I shall perhaps farther allude. We may however, in the absence of better knowledge, take it as

a supposition, that the hurricanes in the Bay of Bengal travel from the Eastward to the Westward,* and it may be quite safe to calculate upon their blowing in a circle from right to left.

We must then *assume* this point, and supposing we have the wind at ESE. we are then *somewhere* upon the line leading from the NNE. point of the hurricane-circle to its centre.

If the wind now veers to SE. and SSE. we can easily understand that the centre has passed somewhere to the Southward of us, and that we are upon the *right* hand side of its track.

But if the wind had begun at North, and veered to the N. West and West we can also understand that the hurricane is passing somewhere to the Northward of us, and that we are upon the *left* hand side of its path. At what distance we are from the centre can only be judged of by the quickness with which the wind veers round; and it will be clear that if a ship stood exactly still with the hurricane coming direct towards her, she might have the wind always in one direction till the centre passed her, when she would probably have a shift exactly in the opposite direction.†

The seaman will now understand how it is that he may be running into a Hurricane or scudding in company with one—which no one of course desires to do—and how important it is that a knowledge of their usual paths should be obtained; for they seem to have in all countries tracks which we may call their usual paths.

As an example how a vessel may run into a hurricane, let us suppose upon our Chart, the Amherst, bound across the Bay from Chittagong to Coringa. It is clear that her course then lies across the track of the Hurricane, and that, if ignorant of what we now know, she might with a little alteration of time, and tempted by the fine Easterly Gale, run into the middle of it; for till now, though a falling Barometer would teach the seaman that he was to expect a tempest, he was quite ignorant, or had only some general rules derived from very partial experience, to inform him where it was beginning, how it would blow, and how he could escape it. We shall know this as I have said before, when we know the usual path of our Indian Hurricanes.

* In an able review of Col. Reid's work in No. 23 of the *Madras Journal of Literature and Science* by T. G. Taylor, Esq. H. C. Astronomer at Madras, he says, "The East India Gales appear invariably to travel from the coast of Arracan towards the West, the curves conforming gradually to the slope of the shore until in about the latitude of Madras when their course is due South, after which the curve binds again towards the West, the violence of the storm seldom extending below Cuddon or Porto Novo." Mr. Taylor speaks here of a *gale*. He does not observe that he has described the curve which a hurricane (i. e. a turning gale) would make on three sides of its circle.

† Col. Reid, p. 8.

The question of scudding or heaving to must it is evident depend upon the commander's judgment as to the position in which he is, his sea-room and the like; but the tack on which he ought to heave to is so clearly indicated by Col. Reid's directions that I cannot do better than extract them; he says page 425,

"*Rules for laying Ships to in Hurricanes.*—That tack on which a ship should be laid to in a hurricane has hitherto been a problem to be solved; and is one which seamen have long considered important to have explained.

"In these tempests when a vessel is lying to and the wind veers by the ship's head, she is in danger of getting stern-way* even when no sail is set; for in a hurricane, the wind's force upon the ship's masts and yards alone will produce this effect, should the wind veer ahead, and it is supposed that vessels have often foundered from this cause.

"When the wind veers aft as it is called, or by the stern, this danger is avoided, and a ship then *comes up* to the wind instead of having to break off from it.

"If great storms obey fixed laws, and the explanation given of them in this work be the true one, then the rule for laying a ship to follows like the corollary to a problem already solved. In order to define the two sides of a storm, that side will be called the right hand semicircle which is on the right of the ship's course, as we look in the direction in which it is moving, just as we speak of the right bank of a river. The rule for laying a ship to will be, when in the *right-hand* semicircle to heave to on the *starboard* tack, and when in the left-hand semicircle on the larboard tack in both hemispheres."

As an example of this on our own diagram. If a line be drawn across those of the 4th and 5th N. 76° E. and S. 76° W. or about WbS. $\frac{1}{2}$ S. and EbN. $\frac{1}{2}$ N., which is the track we have supposed for the hurricane; it will be seen that all the vessels above it, or to the right hand of the hurricane's path, had the wind veering from NE. to South, and were thus safe upon the starboard tack, and all

* From being taken aback. This taking aback in a tempest we all know to be most dangerous, not only on account of the getting stern-way here mentioned; being pooped, dismasted, and the like; but from another danger which is not sufficiently adverted to I think; and this is, that a vessel, may in one of the terrific gusts which accompany these sudden shifts of wind be thrown on her broadside in the trough of the sea *with her deck towards the sea!* In such a case she is in the position of a vessel on a reef which has fallen over to seaward; and there is every chance that her hatches would be beaten in; which would swamp her. A parallel case to this is mentioned in Col. Reid's work, page 221, of the H. C. S. Diana, when part of the upper fore-hatchway was stove in by the weight of the water above it, and the vessel nearly swamped in consequence. Hatches, particularly those of the upper deck, should not only be made stouter than they usually are (they might for lightness be lined with sheet copper or iron) but moreover two extra strong fore and aft-pieces should be made to ship parallel with the middle piece, halfway between it and the side, so as to afford additional support in cases like this. I shall be told that we know of very few instances of this accident. This may arise from few escaping to tell the tale. The number of well-found, stout ships, ably manned and commanded, which disappear induce us to believe that, apart from fire, there are storm-dangers which we can only guess at. I think this may reasonably be supposed to be one of them. H. P.

those below it,* or on the left hand side, had the wind veering from N. to SW. and were thus safe on the larboard tack. The vicinity of the shore, or the necessity of wearing to ease the masts, if the rigging has stretched too much upon one tack, may oblige the seaman to vary from this rule; and close to the centres of the hurricanes anomalies may be found; but it will be seen at once, I think, without further explanation, of what great value it must ultimately prove to him.

I annex here a public order recently issued by the Government of India, and a memorandum by the Lords of the Admiralty and by Lord Glenelg, which will assist in shewing both the seaman and landsman what we require in the way of information on this subject.

Calcutta: Wednesday, 11th September, 1839.—NOTIFICATION.—The importance of investigating the course and Phænomena of Storms has been brought to the notice of Government by the Hon'ble Court of Directors; and the Hon'ble the President in Council is in consequence desirous of obtaining local Registers of these Phænomena taken simultaneously at as many stations of India as may be found possible. The public Officers of the different settlements and stations of India are accordingly invited and requested, upon the occurrence of any Hurricane, Gale or other Storm of more violence than usual, to note accurately the time of its commencement, the direction from which the wind first blows, whether in gusts or regular, and whether accompanied with rain, thunder and lightning or other Phænomena. Also to note, with as much accuracy as possible, the changes of direction in the wind, and the time of the occurrence of each, and lastly, the duration of the Gale and in what quarter the wind is when it ceases. The variations of the Thermometer and Barometer at each period noticed will also be of importance if the means are forthcoming of making such observations.

The President in Council refrains from making it the business of any particular Officer to note the above circumstances, but relies on the known desire of all enlightened persons to promote objects of scientific and useful enquiry that the public Officers will arrange in such manner as to ensure that the observations will be taken by some one in the vicinity of each station.

Reports upon matters of the description comprehended in this Order may be forwarded to the Secretary to Government in the General Department, free of postage, (superscribed "Storm Report.")

A scientific gentleman in Calcutta has obligingly undertaken to combine all reports that may be so received into a synopsis for exhibition of the results in the manner adopted and recommended by Colonel Reid, R. E.

By Order of the Hon'ble the President of the Council of India in Council.

H. T. PRINSEP,
Secy. to the Govt. of India.

* The places of the Justina and Eden, by an oversight, are unfortunately omitted in the diagram of the 5th. It will be seen that they had the wind at SW. and SWbW. on that day.

MEMORANDUM.

Admiralty, Dec. 28th, 1838.

The Lords Commissioners of the Admiralty having had under consideration the general utility of recording with clearness and precision, in the log books of all Her Majesty's ships and vessels of war, the actual state of the winds and weather, have thought fit to order that henceforward in each page of the log book two columns should be introduced, wherein the force of the wind and the appearance of the atmosphere, shall be every hour registered according to the annexed scheme, a copy of which shall be pasted into each book, and painted on the back of every log board or log slate: and two more columns shall likewise be given for the purpose of entering the heights of the barometer or simpiesometer, and thermometer, when such instruments may be on board.

By command of their Lordships,
C. WOOD.

To all Captains, and commanding officers
of Her Majesty's ships and vessels.

FIGURES TO DENOTE THE FORCE OF THE WIND.

0 denotes Calm.					
1 Light Air,	just sufficient to give	Steerage way.			
2 Light Breeze, ..	} with which a well-conditioned man-of-war, under all sail, and clean full, would go in smooth water, from	} 1 to 2 knots.			
3 Gentle Breeze, ..			} 3 to 4 knots.		
4 Moderate Breeze, ..				} 5 to 6 knots.	
5 Fresh Breeze, ..	} in which the same ship could just carry, close hauled, ..	} Royals, &c.			
6 Strong Breeze, ..			} Single-reefs and top-gallant sails.		
7 Moderate Gale, ..				} Double reefs, jib, &c.	
8 Fresh Gale,					} Triple reefs, courses, &c.
9 Strong Gale, ..						} Close reefs & courses.
10 Whole Gale, ..	with which she could only bear	Close reefed main top-sail and reefed fore-sail.			
11 Storm,	with which she would be reduced to	Stay-sails.			
12 Hurricane, ..	to which she could shew ..	No canvas.			

LETTERS TO DENOTE THE STATE OF THE WEATHER.

b Blue sky—whether with clear or hazy atmosphere.	p Passing showers.
c Cloudy— <i>i. e.</i> Detached opening clouds.	q Squally.
d Drizzling rain.	r Rain— <i>i. e.</i> Continuous rain.
f Fog— <i>f</i> thick fog.	s Snow.
g Gloomy dark weather.	t Thunder.
h Hail.	u Ugly threatening appearance in the weather.
l Lightning.	v Visibility of distant objects—whether the sky be cloudy or not.
m Misty or hazy—so as to interrupt the view.	w Wet dew.
o Overcast— <i>i. e.</i> The whole sky covered with one impervious cloud.	. Under any letter denotes an extraordinary degree.

By the combination of these letters, all the ordinary phenomena of the weather may be recorded with certainty and brevity.

EXAMPLES.

b c m Blue sky, with detached opening clouds, but hazy round the horizon.

g v Gloomy dark weather, but distant objects remarkably visible.

q p d l t Very hard squalls, and showers of drizzle, accompanied by lightning, with very heavy thunder.

Nautical Magazine,—March, 1839.

Memorandum respecting the Records to be kept of the state of the Weather in the British Colonies.

The Captains of Ports, Harbour-Masters, and Keepers of lighthouses, or, where those officers do not exist, some other competent public functionary, should be required to keep journals of the weather, on the principle of the log books of ships. A column should be specially reserved for inserting the height of the barometer. Under the head of 'Remarks,' should be entered all meteorological observations considered worthy of particular notice. When the keeper of a journal may hear that a vessel has encountered a storm, he will enter in it any information on the subject which he can rely on, together with the name of the ship, of her owner, and of the port to which she may belong. With the view of tracing the course of storms, the Trinity Board of London have given directions for the adoption of measures to obtain a more accurate record of the weather, than has hitherto been kept, at the lighthouses of Great Britain and Ireland. The keepers of these lights having the opportunity of taking their observations by night as well as by day, great advantage may be derived from employing them in this manner. Officers in charge of Colonial lighthouses should be instructed to keep similar journals. In noting the wind's force, both in the Harbour-Master's journals and in the lighthouse reports, it is desirable that the officers should adopt the numbers for